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ABSTRACT

A comparison was made of short- and long-term visual and auditory memory in relation to visual and auditory interference. The questions investigated were: (1) will interference be greater when it occurs in the same modality (auditory or visual) in which it was learned (i.e., similarity hypothesis), or (2) will interference be greater when it occurs in one specific channel (auditory or visual) regardless of the channel in which it was learned (i.e., channel specificity hypothesis)? Fifty boys and 50 girls, all 6 years old, were randomly assigned to one of two control groups or one of eight experimental groups; each group with the same number of boys as girls. Experimental group subjects learned an original seven-item serial task. Four of the groups had the items presented visually; four, auditorially. These groups were further subdivided on the basis of the nature of the interference task (i.e., either auditory or visual, and either four items or seven items). Control groups had no interference task. All groups were tested for short-term memory and 7 days later, for long-term memory. Results supported neither of the hypotheses, but indicate that auditory interference leads to a significantly greater decrement in serial order recall than visual interference. (MH)

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John Pierce-Jones, Ph.D., Director

The University of Texas at Austin

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VISUAL AND AUDITORY MEMORY IN CHILDREN

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Visual and Auditory Memory in Children

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In a previous report (Mulry, R. C., & Houston, B. K., 1968) a method was presented which delivered consistently, across a large number of subjects, a high level of long-term memory. Since this task was designed to capture the context of everyday, "life type" learning and memory experience, it was felt that this method was useful for studying various procedures contributing to variations in memory processes and outcomes.

In the present study interest was in comparisons of short-and long-term visual and auditory memory, in relation to visual and auditory interference. Two major questions were investigated: (1) will interference be greater when it occurs in the same modality in which it was learned (i.e., similarity hypothesis) or (2) will interference be greater when it occurs in one specific channel (auditory or visual) regardless of the channel in which it was learned (channel specificity hypothesis).

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Method

Subjects

Fifty boys and 50 girls from an elementary school in Austin, Texas served as subjects (Ss) in this experiment. All Ss were six years of age and were assigned randomly to either one of two control groups or one of eight experimental groups; all groups contained an equal number of boys and girls.

Materials

Black and white drawings of familiar objects were presented serially in the following order:

a) the seven-item original task (dog, shoe, boy, car, tree, horse, bird).

b) the seven-item interference task (cup, house, chair, fish, apple, wagon, boat).

c) the four-item interference task (cup, house, chair, fish).

All pictures were attached to plain cardboard and enclosed in a plastic seal.

Procedure

This study consisted of eight experimental groups and two control groups. For the experimental groups the procedure was as follows: (a) all Ss learned an original seven-item serial task to one perfect trial. For four of the eight experimental groups the items were presented visually (i.e., Ss could see a picture of the object to be

recalled). For the remaining four experimental groups, items were presented auditorially (i.e., Ss were not allowed to view a picture of the object to be recalled). The four visual and four auditory groups were further subdivided in terms of the nature of the interference task (i.e., whether it was to be either an auditory or a visual interference task and whether it was to consist of four or seven items). The two control groups did not receive an interference task, but were tested for short-term memory after the same retention interval as well as for long-term memory seven days later.

In short, the procedure consisted of first learning an original task followed by an interference task for the eight experimental groups but not for the two controls and a test of short-term memory. The overall design of this experiment was that of an incomplete factorial design with eight experimental groups and two control groups.

Response Acquisition Period

Each S was taken individually from his classroom to the experimental room and was seated across a table from the experimenter (E). For the visual groups, Ss were told:

> "We are going to play a game with pictures. When I show you a picture, tell me what it is. Then try to remember which picture comes first, which one comes next and which ones come next. Okay?"

The stack of seven pictures was held by E and presented one by one, face up on the table in front of S. On the practice trial E

placed each card face up, one at a time, and asked S:

"The first picture is a _____?" (or)

"After the dog (e.g.) comes a _____?"

On subsequent trials E asked:

"Which picture comes first?" (or)

"Which picture comes next?"

When the child made an error E corrected him by saying:

"Whoops, after the _____ comes the _____."

For the auditory groups Ss were told:

"We are going to play a game with pictures. The pictures are on the backs of these cards. When I tell you what the picture is, say it to me (practice trial). Then try to remember which picture comes first, which one comes next and which ones come next. Okay?"

The stack of pictures was held by E and presented one by one but only the backs of the cards were shown to S. The remainder of the instructions was the same as for the visual groups.

If the original and the interference tasks were presented through the same sensory channel (e.g., visual-visual) the instructions for the second (interference) task were:

"Now we are going to play another game with pictures just like the first game we played. Okay?"

If the original and the interference tasks were presented through different sensory channels (e.g., visual-auditory), the instructions for the interference tasks were the instructions presented above for the auditory or visual tasks depending on whether the interference task was to be of the auditory or visual kind.

Retention Period

Immediately following the interference task (approximately 30 seconds), Ss were tested for short-term memory. This was accomplished in two different ways; the first being a test of structured recall where Ss were asked:

"Do you remember the first game we played with pictures? Can you remember which picture came first? Which pictures came next (etc.)?"

Ss responses were recorded in the order Ss gave them. They were not corrected for errors. Scoring for number of items recalled yielded a maximum score of seven.

The same testing procedure was repeated for the two control groups after a similar short-term memory retention interval as well as after a seven day, long-term memory retention interval.

Responses were scored for serial order in the following manner and yielded a maximum score of eight:

1) One point was scored for each item when that item followed the item or items that preceded it during learning (maximum score of six).

PS 002996

2) However, in the case of an omission of one or more of the preceding items, serial recall was scored in relation to the nearest preceding item recalled. Thus, Ss were penalized one point for each omission.
3) A point was not scored for inverted items (e.g., items which preceded during recall an item or items which they followed during training).
4) Since the first item of the list learned did not follow any other item, a point was scored when it was recalled in the first serial position (one point).
5) Similarly, since the last item was not followed by another item, a point was scored when it was recalled in the last serial position (one point).

Results

Training Trials

To analyze for differences in number of training trials to criterion a one-way analysis of variance was done. Means for this analysis are presented in Table 1 and are summarized in Table 2. Results of this analysis indicated no significant differences between the ten groups in number of training trials to criterion on the original seven-item list ($F = 1.27$, $p > .20$). To determine whether significant differences in number of training trials occurred between the four experimental treatment groups (visual-visual, visual-auditory, auditory-auditory, auditory-visual) and between the two different

TABLE 1

Mean Number of Training Trials: Original List

	Control (Vis.)	Control (Aud.)
	N = 10	N = 10
	M = 2.9	M = 3.5

	Vis.		Aud.	
	Vis. (I)	Aud. (I)	Vis. (I)	Aud. (I)
4-Item	N = 10	N = 10	N = 10	N = 10
	M = 4.2	M = 2.6	M = 3.8	M = 4.0
7-Item	N = 10	N = 10	N = 10	N = 10
	M = 3.3	M = 3.1	M = 3.8	M = 4.0

I = Interference Task

TABLE 2

Summary Table for One-Way ANOV for

Number of Training Trials: Original List

Source		df	MS	F	P
Groups	25.36	9	2.82	1.27	
Error	199.60	90	2.22		

degrees of interference (4 and 7 items), a four by two analysis of variance was performed. Means for this analysis are presented in Table 3 and are summarized in Table 4.

Results indicated no significant differences in number of training trials between the four treatment groups. As expected the seven-item interference task led to a greater number of trials to criterion than did the four-item interference task ($F = 10.68$, $p < .005$). The interaction was not significant.

Short-Term Memory

Short-term memory data were analyzed through an incomplete factorial design where there existed eight treatment groups and two controls. Means for this analysis are presented in Table 5.

F's were calculated for the nine orthogonal comparisons. The following analysis is for the number of items recalled. The comparisons between the visual and auditory control groups with their four experimental groups indicated a significant interference effect in the experimental groups. For the comparison of items recalled between the control group and the four treatment groups where the original material was learned in the visual mode a significant difference was obtained ($F = 37.34$, $p < .001$). This was also true of the comparison of the auditory control group with the four treatment groups where the original material was learned in the auditory mode ($F = 45.62$, $p < .001$).

TABLE 3

Mean Number of Training Trials: Interference Lists

	Vis.-Vis. (I)	Vis.-Aud. (I)	Aud.-Vis. (I)	Aud.-Aud. (I)
4-Items	N = 10 M = 2.4	N = 10 M = 2.3	N = 10 M = 2.2	N = 10 M = 2.9
7-Items	N = 10 M = 3.9	N = 10 M = 4.9	N = 10 M = 3.9	N = 10 M = 3.9

I = Interference Tasks

TABLE 4

Summary Table for 4 X 2 ANOV for

Number of Training Trials: Interference Lists

Source		df	MS	F	p
Number of Items	57.80	1	57.80	10.68	< .005
Groups	3.70	3	1.23	.23	
Number of Items X Groups	6.70	3	2.23	.41	
Error	389.60	72	5.41		

TABLE 5

Mean Number of Items Recalled

	Control (Vis.)		Control (Aud.)	
	N = 10		N = 10	
	M = 6.9		M = 7.0	
	Vis.		Aud.	
	Vis. (I)	Aud. (I)	Vis. (I)	Aud. (I)
4-Item	N = 10	N = 10	N = 10	N = 10
	M = 2.8	M = 2.3	M = 2.3	M = 2.4
7-Item	N = 10	N = 10	N = 10	N = 10
	M = 5.9	M = 5.2	M = 5.6	M = 5.1

I = Interference List

(Maximum Mean Score = 7.0)

TABLE 6

Summary Table for Incomplete Factorial Design

(9 Orthogonal Comparisons): Number of Stimuli Recalled

Source		df	MS	F	P
Original List	.49	1	.49	.28	
Interference List	3.20	1	3.20	1.84	
Number of Items	180.00	1	180.00	103.45	< .001
Original List X Interference List	.80	1	.80	.46	
Original List X Number of Items	.00	1	.00		
Interference List X Number of Items	.80	1	.80	.46	
Original List X Interference List X Number of Items	.20	1	.20	.11	
Control (Vis.)	64.98	1	64.98	37.34	< .001
Control (Aud.)	79.38	1	79.38	45.62	< .001
Error	156.90	90	1.74		

Similarly, a stronger interference effect was obtained for the seven-item interference list than for the four-item list ($F = 103.45$, $p < .001$). The other six comparisons were not significant. To analyze for short-term memory of serial order, the same analysis was employed. Means for this analysis are presented in Table 7.

Results of this analysis were identical to those reported in Table 6 with one important additional significant effect related to auditory versus visual interference. In short, auditory interference led to a significantly greater decrement in recall of serial order regardless of the channel through which the original material was learned ($F = 5.00$, $p < .05$).

Long-Term Memory

Long-term memory was compared to short-term memory for both visual and auditory sensory channels through the use of a between-within subjects analysis of variance design (repeated measures). Means for this analysis are presented in Table 9 and relate to the control groups only.

Results of this analysis indicated a statistically significant loss in mean number of items recalled over the seven day interval ($F = 24.93$, $p < .001$). There was no difference between the auditory and visual main effects ($F = .00$).

The reader will recall that the highest mean score possible on the structured recall task was 7.00. The difference between the means

TABLE 7

Mean Scores: Serial Order

	Control (Vis.)		Control (Aud.)	
	N = 10		N = 10	
	M =		M =	
	Vis.		Aud.	
	Vis. (I)	Aud. (I)	Vis. (I)	Aud. (I)
4-Item	N = 10	N = 10	N = 10	N = 10
	M = 2.7	M = 2.3	M = 2.3	M = 2.2
7-Item	N = 10	N = 10	N = 10	N = 10
	M = 6.5	M = 5.3	M = 6.5	M = 4.9

I = Interference Task

(Maximum Mean Score = 8.0)

TABLE 8

Summary Table for Incomplete Factorial Design

(9 Orthogonal Comparisons): Serial Order

Source		df	MS	F	P
Original List	.64	1	.64	.24	
Interference List	13.61	1	13.61	5.00	< .05
Number of Items	234.61	1	234.61	86.25	< .001
Original List X Interference List	.01	1	.01		
Original List X Number of Items	.01	1	.01		
Interference List X Number of Items	6.61	1	6.61	2.43	> .10
Original List X Interference List X Number of Items	.61	1	.61	.22	
Control (Vis.)	92.48	1	92.48	34.00	< .001
Control (Aud.)	111.01	1	111.01	40.81	< .001
Error	244.40	90	2.72		

TABLE 9

Short-Term and Long-Term Memory: Mean Number of Items Recalled (Repeated Measures)

	Short-Term	Long-Term
Vis. (N = 10)	6.9	6.1
Aud. (N = 10)	7.0	6.1

(Maximum Mean Score = 7.0)

TABLE 10

Summary Table for Repeated Measures Design:

Long-and Short-Term Memory: Number of Items Recalled

Source		df	MS	F	P
Conditions	.05	1	.05	.12	
Trials	7.23	1	7.23	24.93	< .001
Conditions by Trials	.05	1	.05	.12	
Error (b)	7.42	18	.41		
Error (w)	5.24	18	.29		

for short-term memory on this task (6.95) and that for long-term memory (6.10) is very small and indicates that very little of the learned material was forgotten over the seven day period.

A similar analysis was done for recall of serial order. Means for this analysis are presented in Table 11. Analysis of the serial order data indicated poorer retention at the 7-day testing period ($F = 15.63$, $p < .001$). Again, with a possible score of 8 the means differ minimally between 7.65 for short-term memory and 6.15 for long-term memory. All other effects were non-significant. These results are summarized in Table 12.

Discussion

This study was conducted to examine two empirical questions relating to a) the similarity hypothesis that interpolated material has a greater interferring effect when it is learned in the same sensory channel as the original material and b) the channel specificity hypothesis that a specific channel, either auditory or visual, will have greater interferring effects regardless of the channel through which the original material was learned. Results indicated that neither process had an effect on structured recall but that auditory interference led to a significantly greater decrement in serial order recall than did visual interference. Thus, some support for the channel specificity hypothesis was found but only for the dependent variable of memory for serial order.

TABLE 11

Short-Term and Long-Term Memory: Mean

Serial Order Score (Repeated Measures)

	Short-Term	Long-Term
Vis. (N = 10)	7.6	6.7
Aud. (N = 10)	7.7	5.6

(Maximum Mean Score = 8.0)

TABLE 12

Summary Table for Repeated Measures Design:

Long-and Short-Term Memory: Serial Order

Source		df	MS	F	P
Conditions	5.00	1	5.00	3.97	< .10
Trials	22.50	1	22.50	15.63	< .001
Conditions X Trials	3.60	1	3.60	2.50	< .10
Error (b)	22.60	18	1.26		
Error (w)	25.90	18	1.44		

It is very possible that these results are an understatement of the possible net effect of auditory interference. That is, in the present study, S's memory for structured recall was so high that it may have precluded the observation of possible but subtle auditory interference effects like those observed in the present study.

Since these results were obtained within a specific set of operations that have been held constant across the performance of 151 Ss (100 in the present study and 51 from the Mulry, Houston study reported earlier) it is clear that generalizations from the data are grounded on a rather extensive sample of Ss. Of some importance is the fact that the two control groups of the present study consisting of "average" 6 year old children performed comparably to the control groups of the Mulry, Houston (1968) study where Ss were culturally deprived 6 year old children in a Head Start Program. It is clear then, that these operations are robust and it can be expected that other investigators following the same operations would replicate these findings. This is of special significance since it is so rare to find different studies of short-and/or long-term memory where experimental operations are either similar or comparable.

One finding that emerges clearly from the present data is that in support of interference theory. When interference was not introduced into the experimental operations, Ss retained a very high level of long-term memory over a period of seven days. However, when interference was introduced, significant decrements in short-term memory

were observed. Thus, what is lost in long-term memory over a period of seven days can be lost in a period of 30 seconds following interference.

In short, results of the present study were generated by a specific method that has yielded replicable findings across two quite diverse subject samples. Since special efforts were exerted to retain the comparability of operations across the various controls and treatment groups, results were comparable and suggestive of important implications for an inclusive theory of memory.

REFERENCES

Mulry, Ray C., & Houston, B. K. Long term memory: an unexpected ceiling effect. Part of the Final Report on Head Start Evaluation and Research: 1967-68 to the Office of Economic Opportunity (Contract Number OEO-4115).